

# EVALUATION OF THE STRECKER SYNTHESIS AS A SOURCE OF AMINO ACIDS ON CARBONACEOUS CHONDRITES

N. R. Lerner, E. Peterson, and S. Chang

NASA-Ames Research Center, Moffett Field, CA 94035

The Strecker synthesis,  $R_2CO + HCN + NH_3 \leftrightarrow R_2C(NH_2)CN + H_2O \rightarrow R_2C(NH_2)CO_2H$ , has been proposed as the source of amino acids formed during aqueous alteration of carbonaceous chondrites (Cronin et al. 1988). It is postulated that the aldehyde and ketone precursors ( $R_2CO$ ) of the meteoritic amino acids originated in interstellar syntheses and accreted on the meteorite parent body along with other reactant species in cometary ices. Formaldehyde is observed in the interstellar medium and in comets, and if produced by ion-molecule reactions would be expected to be D-enriched. The amino acids found in Murchison are D-rich with  $\delta D = 1370$  ‰ (Epstein et al. 1987, Pizzarello et al. 1991). Any proposed synthesis of amino acids must be capable of preserving the D-enrichment of the interstellar precursors during synthesis and aqueous alteration and accounting for the relative abundances of amino acids.

The Strecker synthesis has been run with formaldehyde, acetaldehyde, propionaldehyde, acetone and methyl ethyl ketone as starting materials. The concentrations studied ranged from 0.003M to 0.3M in  $NH_4Cl$  and HCN and from 0.0045M to 1 molar in aldehyde or ketone. In the case of aldehydes, the Strecker synthesis is very efficient in producing amino acids: the yields of amino acids in basic solution at room temperature ranged from 15-95% of theoretical. Yields were decreased by decreasing the temperature to 278K, the concentration of starting materials, or the pH of the solution. In addition to the expected  $\alpha$ -amino acids, compounds such as  $\alpha$ -iminodiacetic acid were formed which could be sought in Murchison samples as an independent chemical indicator of the Strecker synthesis. With acetone as the starting material, less than 1%  $\alpha$ -amino-isobutyric acid formed in basic solution and in solutions buffered at pH 6.5. An improvement in yield to 15% was achieved by acidifying the basic solutions to a pH of 6 to 7 and allowing them to stand for several days. The yields ranged from 8 to 70% when the basic solutions were hydrolyzed in concentrated hydrochloric acid. It is noteworthy that roughly equivalent amounts of glycine and  $\alpha$ -amino-isobutyric acid are observed in Murchison. The low yields of  $\alpha$ -amino-isobutyric acid from the Strecker synthesis, except when pH was drastically lowered in the reaction medium, suggest that if such synthesis had occurred, a similar change in pH would have been necessary during aqueous alteration on the parent body.

To study the effect of minerals on the reaction, the Strecker synthesis was run in the presence and absence of dust from the Allende meteorite using deuterated aldehydes and ketones as starting materials. The products were investigated by GC/MS. With the exception of glycine the retention of deuterium in the amino acids was greater than 90%. Some D-exchange with water does occur, however, and determination of the rate of exchange as a function of pH and temperature may allow some bounds to be placed on the duration of parent body aqueous alteration. For glycine,  $NH_2CD_2CO_2H \gg NH_2CH_2CO_2H > NH_2CHDCO_2H$ , which indicates that some of the glycine might have been formed from HCN and water. The retention of deuterium by the amino acids under conditions studied thus far is consistent with the model that a Strecker synthesis starting from interstellar aldehydes and ketones led to the production of meteoritic amino acids. Additional work is required to strengthen this conclusion.

Cronin, J. R. and Pizzarello, S. (1988) *Meteorites and the Early Solar System*, The U. of Arizona Press, Tucson, 808-853. Epstein et al. (1987) *Nature*, **326**, 477-479. Pizzarello et al. (1991) *Geochimica Cosmochimica Acta* **55**, 905-910.